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GB 2017827 A
EP 0318312 A
EP 0363624 A
US 6351949 B

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(54) Abstract Title

AIR INLET BUSHES USED IN A COMBUSTION CHAMBER OF A GAS TURBINE

(57) A gas turbine has outer and inner walls 2a, 2b, which define an annular space 4 between a combustion chamber 2 and a casing 1 in which there is an air flow. The inner casing is pierced by a plurality of holes 6 having respective fixed bushings 8 which define an air injection passage into the combustion chamber 2. Each bushing has a peripheral wall 10 in which at least one orifice 16 is formed that opens into the combustion chamber in the immediate vicinity of the inner side wall of the combustion chamber. The bushing orifice 16 allows air to flow substantially along the combustion chamber inner side wall. The bushing is characteristically elliptical in section with at least one groove 18 along the peripheral wall opening out into the annular space, and into which the or each orifice 16 connects. The bushing may have a collar 14 which matches the exterior profile of the combustion chamber side wall, and may be flush with the interior wall profile.

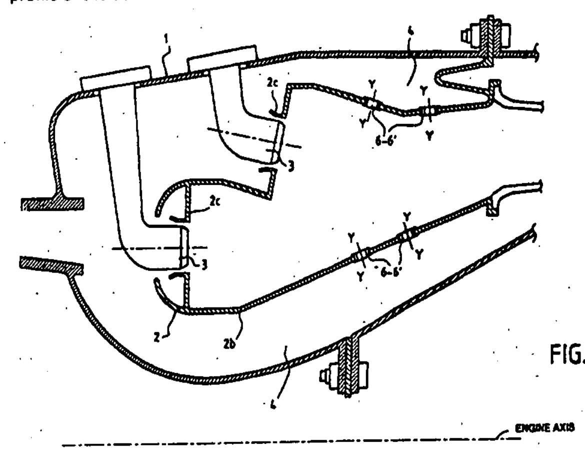

FIG.1

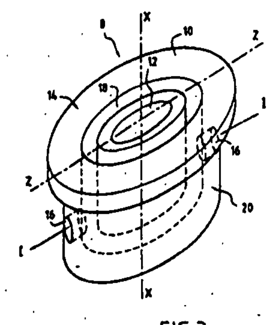

FIG.3

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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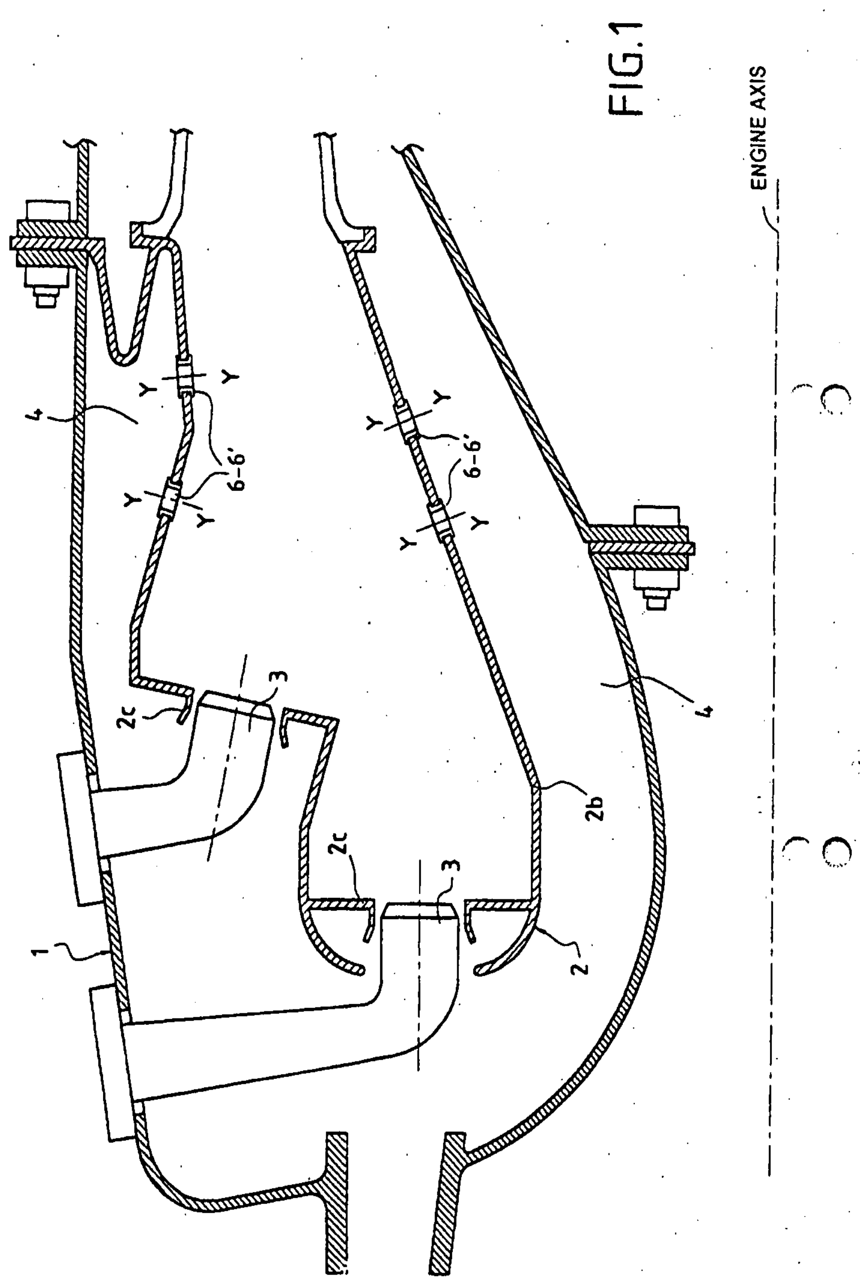

FIG.1

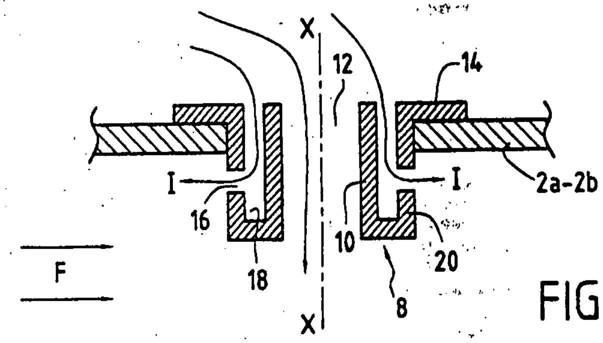

FIG.2A

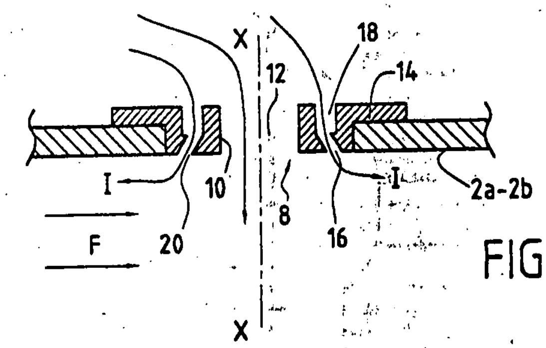

FIG.2B

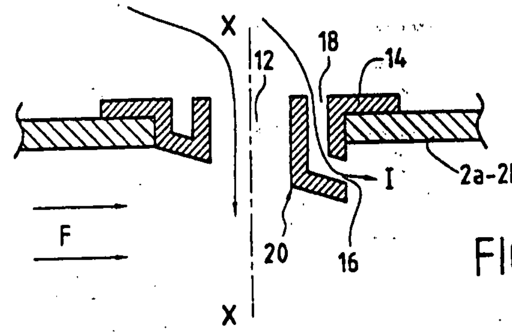

FIG.2C

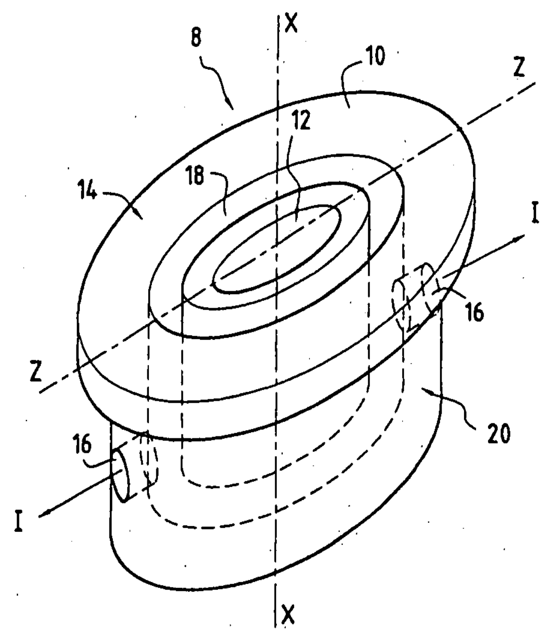

FIG.3

Improvements to gas turbine combustion chambers

The present invention relates to the field of combustion chambers for airplane gas turbine engines, and more particularly to combustion chambers having air injection orifices through their walls.

A combustion chamber for a gas turbine is disposed in conventional manner inside a housing that constitutes a casing. It is made up of inner and outer side walls that are united by an end wall on which injector systems are mounted that are distributed over one or more heads.

Conventionally, the air coming from the high pressure compressor of the turbine is admitted into the combustion chamber. A fraction of this air feeds the combustion zone axially via end wall inj ctor systems and another fraction enters transversely via primary air injection holes pierced through the inner and outer side walls of the combustion chamber. A further fraction of this air, referred to as a "dilution" fraction, is also introduced transversely, but further downstream within the combustion chamber. It is introduced via one or more rows of holes distributed through the inner and outer side walls of the combustion chamber.

Because of the high temperatures that exist inside the combustion chamber, its inner and outer walls generally need to be cooled. Present combustion chambers use cooling methods for this purpose based on films, on tiles, or on multiple perforations.

Multiple perforations comprise multiple cooling air injection orifices in the combustion chamber side walls for the purpose of cooling them. This method of cooling enables the fraction of air that is devoted to cooling to be reduced compared with other methods, thus enabling the fraction that is devoted to combustion to be increased, thereby reducing the production of undesirable gas

emissions. The present invention relates more particularly to this type of combustion chamber cooling method, but it is not limited to this case only.

It is known that piercing multiple perforation orifices in the vicinity of primary combustion air and dilution air injection orifices is undesirable since there is a danger of causing cracks to propagate via said orifices. Unfortunately, the absence of local cooling in this zone gives rise to the appearance of hot points and temperature gradients which disturb the high temperature behavior of the combustion chamber side walls.

In addition, the impact of the air and fuel mixture against the walls of the combustion chamber tends to form hot points at any point within the combustion zone.

In order to solve that problem, a solution that is known from US patent Nos. 4 875 339 and 4 700 544, for example, lies in inserting hollow sleeves or bushings in the injection holes to define passages for injecting combustion or dilution air and also defining side orifices for directing a flow of cooling air substantially along the side wall of the combustion chamber in the immediate vicinity of the injection holes.

Nevertheless, none of those solutions appears to be satisfactory for reducing the temperature gradients which appear all around the air injection holes. In addition, the front portions of the peripheral walls of these bushings which project into the combustion chamber are exposed to hot gases. As a result these bushings tend to become damaged quickly.

The present invention thus seeks to mitigate such drawbacks by proposing bushings that are fixed in the air injection holes of the combustion chamber while providing passages for cooling air to improve the temperature behavior of the combustion chamber walls around said air injection holes, while maintaining a long lifetime.

To this end, the invention provides a combustion chamber for a gas turbine comprising outer and inner side walls interconnected by an end wall, the combustion chamber being received in a casing so as to define an annular space between the combustion chamber and the casing, in which space there is a flow of air for combustion, for dilution, and for cooling the combustion chamber, the side walls of the combustion chamber being pierced by a plurality of holes having respective bushings fixed therein to define air injection passages for injecting air into the combustion chamber, each bushing comprising a peripheral wall in which at least one additional orifice is formed that opens out into the combustion chamber in the immediate vicinity of the side wall of the combustion chamber in which said bushing is fixed so that the air passing through said orifice flows substantially along said side wall, the combustion chamber being characterized in that each bushing is of substantially elliptical right section, the peripheral wall of each bushing including at least one groove opening out into the annular space and into which the or each orifice opens out so as to be fed with air and so as to cool the peripheral wall of the bushing.

The elliptical shape of the bushings serves to reduce the aerodynamic blocking due to the flow of cooling air and thus to attenuate degradation of the cooling film in the vicinity of the injection holes. In addition, the presence of a peripheral groove makes it possible to ensure that air is fed to one or more orifices opening out into the groove and also makes it possible to provide effective cooling of the peripheral wall of the bushing adjacent to its front face which is exposed to the hot gases.

The portions of the bushings that proj ct into the combustion chamber can match substantially the concave shape of the combustion chamber wall so as to minimize degradation of the film of cooling air.

It is possible to vary the number of orifices provided through the peripheral walls of the bushings, the way they are distributed around the circumferences of the bushings, and the amount of air flowing through them, as a function of specific local needs for cooling in the immediate vicinity of the air injection holes.

Other characteristics and advantages of the present invention appear from the following description given with reference to the accompanying drawings which show an embodiment that is not limiting in any way. In the figures:

- Figure 1 is an axial half-section view of a combustion chamber constituting an embodiment of the invention;
- Figures 2A, 2B, and 2C are section views through three embodiments of bushings fitted to the combustion chamber of Figure 1; and
- Figure 3 is a perspective view of a bushing constituting another embodiment of the invention.

Reference is made initially to Figure 1 which is an axial section view of a combustion chamber for an aircraft engine gas turbine.

Typically, a gas turbine possesses a compression section (not shown) in which air is compressed prior to being introduced into a combustion chamber casing 1, and then into a combustion chamber 2 situated therein. Thereafter the air is mixed with fuel injected into the combustion chamber prior to being burnt therein. The gas generated by this combustion is then directed towards a high pressure turbine (not shown), prior to being exhausted.

In the embodiment shown in Figure 1, the combustion chamber 2 is of the annular type. Naturally, the present

invention also applies to any other shape of combustion chamber.

The combustion chamber 2 is defined by outer and inner side walls 2a and 2b interconnected by an end wall 2c fitted with injector systems 3 through which fuel is introduced into the combustion chamber. Conventionally, such injector systems are distributed over one or more heads. The present invention applies equally well to combustion chambers with one or multiple heads having injector systems which serve either to spray fuel mechanically, aerodynamically, or premixed, or else to vaporize it.

The casing 1 co-operates with the combustion chamber 2 to leave an annular space 4 into which there is admitted the compressed air for combustion, for dilution, and for cooling the combustion chamber. The combustion chamber comprises a primary zone or combustion zone proper, and a secondary zone or dilution zone situated downstream therefrom.

Air is supplied to the combustion zone by being introduced axially via the end wall 2c (via injector systems 3, for example), and it is also introduced transversely via injection holes 6 pierced through the outer and inner side walls 2a and 2b of the combustion chamber 2.

The air supplied to the secondary zone is also introduced transversely, but further downstream along the combustion chamber via one or more rows of holes 6' distributed in the inner and outer side walls of the combustion chamber.

The side walls of the combustion chamber 2 could be cooled by a conventional method based on multiple perforations through the walls. Nevertheless, the present invention also applies to combustion chambers that make use of other types of cooling (by films, by tiles, ...).

The outer and inner side walls 2a and 2b of the combustion chamber 2 have bushings 8 fixed in the air injection holes 6, 6'. These bushings are substantially elliptical in right cross-section and they are made as precision castings, having inside dimensions that correspond to the size of the injection holes, and they are fixed in said holes by a plurality of beads of welding or brazing. For reasons of cost and ease of repair, it nevertheless appears advantageous for the bushings to be fixed by welding. The elliptical shape of the bushings serves to reduce the aerodynamic blocking due to the flow of cooling air, thereby attenuating the degradation of the cooling film in the vicinity of the injection holes.

Each bushing 8 comprises a peripheral wall 10 defining a central passage 12 for air on the central axis X-X of the bushing. In its rear portion, the peripheral wall 10 forms a collar 14 that bears against the outside face of the side walls 2a, 2b of the combustion chamber in which said bushing is fixed. Advantageously, the collar 14 is shaped so as to match the shape of the combustion chamber side wall.

These bushings 8 have air feed means for simultaneously improving the thermal behavior of the inner and outer side walls 2a and 2b around the injection holes 6 and 6' in which they are fixed, and also to improve the thermal behavior of the bushings themselves.

With reference more particularly to Figures 2A to 2C, there can be seen an annular peripheral groove 18 of substantially elliptical shape that is formed in the peripheral wall 10 of each bushing 8. This groove opens to the rear face of the bushing 8 in the annular space 4. Air injection orifices 16 pass through the peripheral wall of each bushing 8. Each orifice 16 opens out both into the groove 18 at or close to the bottom of the groove, and also into the combustion chamber in the immediate vicinity of the side walls 2a, 2b of the

combustion chamber 2 in which the bushing is fixed so that the air which passes through said orifice is caused to flow substantially along said side wall.

The groove 18 constitutes a channel for feeding the orifices 16 with cooling air. The air travelling along said groove also serves to cool the peripheral wall 10 of the bushing, particularly in the vicinity of the front face of the bushing which is exposed to hot gas. The presence of the groove 18 reduces the thickness of the peripheral wall in the front portion 20 thereof, thereby providing cooling that is more effective.

The orifices 16 enable a cooling film to be established around the air injection holes 6, 6'. The orifices are directed in such a manner as to minimize interaction between the streams of air I leaving the orifices and the stream F of gas generated by the combustion of the air-fuel mixture.

In the embodiment of Figure 2A, the orifices 16 open out substantially parallel to the side walls 2a, 2b in which the bushing is fixed. The orifices 16 open out into the combustion chamber through the front portion 20 of the bushing which projects into the inside of the combustion chamber from the side walls 2a, 2b in which said bushing is fixed.

In order to minimize degradation of the film of cooling air travelling along the side wall of the combustion chamber, the front portion of the bushing can be flush relative to said peripheral wall, as shown in Figure 2B. Under such circumstances, it matches any concave shape of the side wall of the combustion chamber. The air flowing through the orifices 16 is then ejected in a direction that is different from that which can be achieved using orifices in a bushing whose peripheral wall has a front portion that projects into the inside of the combustion chamber. Nevertheless, this direction slopes relative to the axis of the bushing such that the air stream I leaving these orifices is still caused to

flow substantially along the side wall of the combustion chamber.

As shown in Figure 2C, the front portion 20 of the peripheral wall 10 of each bushing can also be semi-flush, i.e. it can project into the inside of the combustion chamber on the side of the bushing that is downstream in the gas flow direction, while being flush on its upstream side. Under such circumstances the orifice(s) 16 can open out into the combustion chamber parallel to its side wall in the downstream front portion that projects into the combustion chamber.

Figure 3 shows that the major axis Z-Z of the elliptically-shaped bushing 8 extends substantially parallel to the flow axis F of the gas generated by the combustion. Naturally, this axis Z-Z could also be at an angle relative to the axis F. Furthermore, in this embodiment as shown in Figure 3, the bushing has two orifices 16 fed from a common groove 18 formed all around the peripheral wall 10 of the bushing. The air stream I leaving each of these orifices is directed substantially parallel to the side wall of the combustion chamber, but it is inclined relative to the axis F of the combustion gas stream.

The number of orifices is not limiting, a bushing could have a single orifice or a plurality of orifices with the air streams leaving them being substantially parallel or inclined relative to the axis F. For example, the bushing could have four air injection orifices 16 angularly distributed at regular intervals around its entire peripheral wall 10. The air stream I leaving via these orifices is thus distributed in substantially uniform manner around the holes 6, 6' in which said bushing is fixed. The orifices are fed from a common annular groove 18 extending all around the peripheral wall of the bushing 8.

It is also possible to adjust the air flow rate leaving each orifice 16 by varying the dimensions of the

right sections of these orifices. Thus, it is possible to achieve a non-uniform distribution of air flow rates around the circumference of the bushing depending on whether it is desirable for cooling to take place at different rates in different sectors covered by said orifices.

In addition, the central axis X-X of each bushing 8 can either coincide with the normal Y-Y to the side wall of the combustion chamber in which said bushing is fixed, or else it can be inclined relative thereto so as to impart any desired direction on the flow of air injected into the combustion chamber in order to obtain more uniform cooling inside the combustion chamber.

Naturally, the present invention is not limited to the embodiments described above but covers all variants thereof. Thus, it is possible to devise a bushing presenting an axis that coincides with or that is offset relative to the axis of the hole in which the bushing is fixed, that presents one or more air injection orifices distributed around the circumference thereof, and having a bottom face that is flush or that projects relative to the side wall of the combustion chamber.

CLAIMS

1/ A combustion chamber (2) for a gas turbine comprising outer and inner side walls (2a, 2b) interconnected by an end wall (2c), the combustion chamber being received in a casing (1) so as to define an annular space (4) between the combustion chamber and the casing, in which space there is a flow of air for combustion, for dilution, and for cooling the combustion chamber, the side walls of the combustion chamber being pierced by a plurality of holes (6, 6') having respective bushings (8) fixed therein to define air injection passages for injecting air into the combustion chamber, each bushing (8) comprising a peripheral wall (10) in which at least one additional orifice (16) is formed that opens out into the combustion chamber (2) in the immediate vicinity of the side wall (2a, 2b) of the combustion chamber in which said bushing is fixed so that the air passing through said orifice flows substantially along said side wall, the combustion chamber being characterized in that each bushing is of substantially elliptical right section, the peripheral wall (10) of each bushing including at least one groove (18) opening out into the annular space (4) and into which the or each orifice (16) opens out so as to be fed with air and so as to cool the peripheral wall of the bushing.

2/ A combustion chamber according to claim 1, characterized in that each bushing (8) comprises a collar (14) pressed against the side wall (2a, 2b) of the combustion chamber in which the bushing is fixed so as to match the shape of said side wall.

3/ A combustion chamber according to claim 1 or claim 2, characterized in that the front portion (20) of the peripheral wall (10) of each bushing (8) projects into the inside of the combustion chamber (2) relative to the

side wall (2a, 2b) of the combustion chamber in which the bushing is fixed.

4/ A combustion chamber according to claim 1 or claim 2, characterized in that the front portion (20) of the peripheral wall (10) of each bushing (8) which opens out into the combustion chamber is semi-flush relative to the side wall (2a, 2b) of the combustion chamber in which the bushing is fixed.

5/ A combustion chamber according to claim 1 or claim 2, characterized in that the front portion (20) of the peripheral wall (10) of each bushing which opens out into the combustion chamber is flush relative to the side wall (2a, 2b) of the combustion chamber in which the bushing is fixed so as to minimize degradation of the cooling air film.

6/ A combustion chamber according to any preceding claim, characterized in that the central axis (X-X) of each bushing (8) coincides substantially with the normal (Y-Y) of the side wall (2a, 2b) of the combustion chamber in which the bushing is fixed.

7/ A combustion chamber according to any one of claims 1 to 5, characterized in that the central axis (X-X) of each bushing (8) slopes relative to the normal (Y-Y) of the side wall (2a, 2b) of the combustion chamber in which the bushing is fixed.

8/ A combustion chamber according to any one of claims 1 to 7, characterized in that each bushing (8) possesses a major axis (Z-Z) extending substantially parallel to the flow direction (F) of the gas generated by burning fuel.

9/ A combustion chamber according to any one of claims 1 to 7, characterized in that each bushing (8) possesses a

major axis (Z-Z) whose direction is inclined relative to the flow direction (F) of the gas generated by burning fuel.

10/ A combustion chamber according to any preceding claim, characterized in that each bushing (8) has a plurality of orifices (16) angularly distributed around its peripheral wall (10).

11/ A bushing (8) for fixing in air injection holes (6, 6') pierced through the outer and inner side walls (2a, 2b) of a combustion chamber (2) for a gas turbine, the bushing comprising at least a central passage (12) for injecting air and a peripheral wall (10) in which there is formed at least one additional air injection orifice (16), the bushing being characterized in that each bushing possesses a right section that is substantially elliptical, its peripheral wall having at least one groove (18) opening out into a rear face of the bushing and into which the or each orifice (16) opens out so as to be fed with air and so as to cool the peripheral wall of the bushing.

12/ A bushing (8) according to claim 11, characterized in that it has a plurality of air injection orifices (16) angularly distributed around its peripheral wall (10).

13/ A combustion chamber substantially as hereinbefore described with reference to Figure 1 of the drawings.

14/ A bushing substantially as hereinbefore described with reference to any one of Figures 2A, 2B, 2C or 3 of the drawings.

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Application No:	GB 0214049.9	**Examiner:**	Brian A Woods
Claims searched:	1-14	**Date of search:**	5 November 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): F4T(TAA,TAB,TAC,TAD,TAE,TAF,TAR4,TAR5,TAR6)

Int Cl (Ed.7): F23R(3/04,3/06); F02C

Other: On-Line: WPI; EPODOC; JAPIO; TXTE;

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2017827 A	(GEN ELECTRIC) See figs disclosing non-elliptical bush.	
A	EP 0363624 A1	(WESTINGHOUSE) See figs disclosing non-elliptical bush.	
A	EP 0318312 A1	(GEN ELECTRIC) See figs disclosing non-elliptical bush.	
A	US 6351949	(ALLISON) See figs disclosing substantially non-elliptical bush.	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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